

## ENABLING COEXISTENCE BETWEEN WIRELESS NETWORKS AND RADAR SYSTEMS

### TECHNICAL FIELD

[0001] This invention relates generally to wireless networks and, more specifically, relates to sharing radar bands between wireless networks and radar systems.

### BACKGROUND

[0002] This section is intended to provide a background or context to the invention disclosed below. The description herein may include concepts that could be pursued, but are not necessarily ones that have been previously conceived, implemented or described. Therefore, unless otherwise explicitly indicated herein, what is described in this section is not prior art to the description in this application and is not admitted to be prior art by inclusion in this section. Abbreviations that may be found in the specification and/or the drawing figures are defined below at the end of the specification but prior to the claims.

[0003] The coexistence of wireless systems (such as a Wi-Fi system) and radar seems to be forbidden by regulatory requirements, as regulatory requirements deny use of a wireless channel if radar has been detected. However, with the recent Presidential Council of Advisory for Science and Technology (PCAST) report, the military bands (S band) will be unleashed for secondary uses of communications systems (e.g., Wi-Fi and LTE as examples). Based on this report, DARPA has approved a recent project termed as Shared Spectrum Access of Radar Bands by Communications systems (SSPARC).

[0004] Military radars typically operate in the so-called S-band (2-4 GHz) and beyond with high transmission power (e.g., 150 KW) using phased array antennae. The radar signals are extremely susceptible to interference from other communications systems, leading to severe degradation in detection performance of target applications.

[0005] Meanwhile, with respect to Wi-Fi systems, channel access in Wi-Fi systems is based on contention among active STAs having UL traffic. That is, all Wi-Fi systems are contention-based TDD systems where the access point and the mobile stations all vie for use of the same channel. The traditional method of contention used in Wi-Fi systems is carrier sense multiple access-collision avoidance (CSMA-CA), where a STA needs to sense for an idle channel prior to its transmission. The interframe sensing (IFS) interval and the corresponding back-off method to reduce collisions are typical overheads of any Wi-Fi system.

[0006] If Wi-Fi and other wireless systems are to coexist with radar systems, the wireless users will be treated as secondary users and need to impart reduced interference (relative to normal operation) to the radar signals. In the absence of a coexistence mechanism, wireless devices such as STAs in a Wi-Fi system may contend for the channel and access the channel medium when the channel medium is sensed by a STA as being idle. However, during transmissions, if a radar signal appears, the ongoing transmissions will collide with the radar signal, resulting in packet loss of such STAs and other wireless devices. Since the exclusion zone of a radar signal is significant, concurrent transmissions will result in reduced system throughput. Moreover, for the example of STAs, these STAs may assume collisions with other STA

transmissions and continue retransmissions with subsequent failure, since STAs are not being informed of radar operation.

[0007] In other words, in case coexistence among wireless systems such as LTE or Wi-Fi systems with radars is allowed, a problem is that there are no obvious solutions as to how to guarantee both radar operation and wireless operation in the same or adjacent channels.

### SUMMARY

[0008] This section contains examples of possible implementations and is not meant to be limiting.

[0009] An exemplary method includes determining information about a radiation pattern of a radar beam, wherein the radar beam uses a bandwidth. The method includes determining based on the information about the radiation pattern whether a channel using at least a portion of the bandwidth is or is not available for access by mobile devices. The method includes transmitting to the mobile devices one or more specific broadcast frames by a wireless access node configured to advertise whether the channel is or is not available for access by the mobile devices.

[0010] In another exemplary embodiment, an apparatus includes: means for determining information about a radiation pattern of a radar beam, wherein the radar beam uses a bandwidth; means for determining based on the information about the radiation pattern whether a channel using at least a portion of the bandwidth is or is not available for access by mobile devices; and means for transmitting to the mobile devices one or more specific broadcast frames by a wireless access node configured to advertise whether the channel is or is not available for access by the mobile devices.

[0011] An exemplary apparatus includes one or more processors and one or more memories including computer program code. The one or more memories and the computer program code are configured to, with the one or more processors, cause the apparatus to perform at least the following: determining information about a radiation pattern of a radar beam, wherein the radar beam uses a bandwidth; determining based on the information about the radiation pattern whether a channel using at least a portion of the bandwidth is or is not available for access by mobile devices; and transmitting to the mobile devices one or more specific broadcast frames by a wireless access node configured to advertise whether the channel is or is not available for access by the mobile devices.

[0012] An exemplary computer program product includes a computer-readable storage medium bearing computer program code embodied therein for use with a computer. The computer program code includes: code for determining information about a radiation pattern of a radar beam, wherein the radar beam uses a bandwidth; code for determining based on the information about the radiation pattern whether a channel using at least a portion of the bandwidth is or is not available for access by mobile devices; and code for transmitting to the mobile devices one or more specific broadcast frames by a wireless access node configured to advertise whether the channel is or is not available for access by the mobile devices.

[0013] An additional exemplary embodiment includes a computer program, comprising code for determining information about a radiation pattern of a radar beam, wherein the radar beam uses a bandwidth; code for determining based on the information about the radiation pattern whether a channel using at least a portion of the bandwidth is or is not available for access by mobile devices; and code for transmitting to the mobile devices one or more specific broadcast frames by a